

Helios Mission Support

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Project Helios is a cooperative U.S./West German space effort. Two unmanned solar-orbiting spacecraft are planned to be launched: the first in mid-1974, and the second in late 1975. These spacecraft will follow a trajectory that brings them closer to the Sun (under 0.3 AU) than any known program to date. Using specially designed instruments, the Helios spacecraft will enter unexplored regions near the Sun in an attempt to expand mankind's knowledge of how the Sun influences life on Earth. In addition to the scientific goals, Project Helios presents many challenging technological problems—none the least of which is to design a spacecraft which will endure 16 times the amount of heat from the Sun (at 0.25 AU) than is normally received on Earth. In addition, the spacecraft reaches its closest approach to the Sun (perihelion) in only 90 days after launch. These and other facets of this unique mission were described in Volumes II through VI of this series. Volume VII treated the JPL/TDS activities during the Sixth Helios Joint Working Group Meeting held at Oberpfaffenhofen, West Germany, October 20 to 27, 1971. This article covers the DSN Helios activities since that date.

I. Introduction

The previous article (Ref. 1) highlighted the activities of the U.S./German TDS subgroup in support of the Fifth *Helios* Joint Working Group Meeting held at Oberpfaffenhofen (near Munich), West Germany, October 20–27, 1971. As mentioned in that article, considerable progress was made—both in culminating prior efforts and in establishing a firm basis for future efforts. It is, therefore, the intent of this article to summarize the NASA–TDS activity that has transpired since the Fifth *Helios* Joint Working Group Meeting, and also to mention briefly the planning effort that is under way in anticipation of the Sixth *Helios* Joint Working Group Meeting, to be held at JPL April 26, through May 3, 1972.

II. NASA Support Plan (NSP)

One of the highlights of the Fifth *Helios* Joint Working Group Meeting was the issuance by the Project Office of the preliminary Support Instrumentation Requirements Document (SIRD). The issuance of the SIRD (even though preliminary) represented an important *Helios* Project/DSN milestone in that it defined for the first time the specific network support requirements needed by the *Helios* Project Officer in order to accomplish their mission objectives. As a result of the publication of the preliminary *Helios* SIRD, the DSN was able to initiate the planning effort leading toward a NASA Support Plan (NSP). This effort, which is still under way, will lead first to a preliminary issue of the NSP covering the support for the Deep

Space Phase. Incorporation of the Near-Earth Phase Support sections of the NSP will, of necessity, have to await the preparation of the actual launch trajectories available to Project *Helios*. Preliminary versions of the latter are not expected until late in 1972, with final versions not becoming known until after mid-1973.

DSN planning to date is based upon the assumption that DSS 11 (Pioneer DSS), DSS 42 (Weemala DSS) and DSS 62 (Cabreros DSS) 26-m subnetwork will provide the major telemetry, command, and radio-metric coverage during the *Helios* primary mission (Mission Phases I and II). In addition, it is expected that selected coverage will be provided by the DSN 64-m antenna facilities at the Goldstone and Tidbinbilla DSCCs during the first perihelion portion of the *Helios* mission. *Helios* support by the Madrid, Spain, 64-m DSN antenna facility is not presently contemplated, since the West German 100-m antenna facility at Effelsberg is expected to provide enhanced telemetry coverage from that longitude. As mentioned in previous volumes, the West German station facilities (Effelsberg and Weilheim) and the DSN will cooperate in providing the needed *Helios* support. The combination of the DSN's 26-m subnetwork and the two 64-m facilities is, however, expected to provide the majority of the tracking and data acquisition support for Project *Helios*, since the more northerly latitude of the West German Effelsberg station restricts its visibility of the *Helios* spacecraft to approximately 4 to 6 h/day—depending upon the time of year. Nonetheless, the Effelsberg antenna, due to its higher gain, is expected to provide valuable support to the *Helios* Project—especially when the spacecraft is at its maximum range from Earth (Fig. 9 of Vol. VI of this series). Nonetheless, as stated in Vol. VI, the *Helios* telecommunications link design specification is such that all primary mission objectives can be accomplished utilizing only the DSN 26-m subnetwork. Therefore, the primary emphasis within the Deep Space Phase portion of the NSP will relate to the capabilities of the DSN 26-m antenna subnetwork—i.e., DSSs 11, 42, and 61. However, all data obtained, regardless of which size DSN antenna is providing the support, will be made available to the *Helios* Mission Operations Team. The NSP is, therefore, expected to fulfill most, if not all, of the requirements set forth in the *Helios* Project SIRD.

III. Compatibility Test Planning

The first full-scale compatibility tests between the *Helios* spacecraft telecommunications system and the DSN are presently scheduled to be conducted in April–May 1972. These tests will employ the engineering model

(EM) version of the *Helios* spacecraft radio system—minus the digital data handling subsystem. These tests, which are to establish basic spacecraft/DSN compatibility, have been intentionally scheduled sufficiently early in the *Helios* spacecraft development cycle to permit design modifications should any be deemed necessary subsequent to the compatibility tests. Planning effort directed toward the engineering model compatibility tests has been under way for approximately one year. It has involved both the *Helios* Spacecraft Project Office and the DSN. As of this time, both a Management Plan and a Test Plan have been published (Refs. 2 and 3). In preparation is a document covering the actual test procedures to be used during the *Helios* engineering model/DSN compatibility tests. This latter document is scheduled for publication just prior to the start of the compatibility tests in order that its information will be as current as possible. In addition, a report covering the results of the tests is planned for publication.

According to the present schedule, the EM compatibility tests will be conducted at DSS 71, Cape Kennedy, Florida. The EM transponder and its associated ground support equipment will be located either within the DSS 71 facility or in the shield room at Hangar AO, Cape Kennedy—depending upon the nature and requirements of the particular test under way at the time. For those tests conducted within DSS 71, coaxial “hard-line” connections will be made between the EM transponder and the DSS 71 station equipment. For those tests conducted with the EM transponder located within the Hangar AO shield room, RF microwave paths (operating passively on the *Helios* frequencies) will be employed to interconnect the transponder with DSS 71. In either event, computer-controlled attenuators, programmers, etc., will be employed to automate the tests cycles—with the results being presented on a standard computer line printer. This unique capability of the two DSN compatibility test facilities, DSS 71 and CTA 21, greatly reduces the time and manpower that would otherwise be required to perform these essential tests.

While the EM compatibility tests at DSS 71 represent an important Project milestone, it will not be the first time that portions of the *Helios* radio system have interfaced with the DSN. During mid-summer 1971, the *Helios* spacecraft command detector modules were laboratory-tested at JPL, and in December 1971 the newly redesigned *Helios* spacecraft receiver was similarly tested. During the latter tests, the *Helios* spacecraft receiver was connected to a spare *Mariner* spacecraft transmitter to form a complete transponder which was then patched to the

JPL CTA 21 facility for end-to-end tests. At that time, there were no indications of a serious incompatibility between the contemplated *Helios* spacecraft radio system design and the DSN. Because of this fact, both the *Helios* Project Office and the DSN are optimistic that the EM compatibility tests at DSS 71 will proceed on schedule.

IV. Action Items

As mentioned in the previous article (Ref. 1) the semi-annual *Helios* Joint Working Group meetings not only present a forum for the exchange of technical information but also establish the plans for future effort. Many of these plans result in the assignment of action items upon the various subgroup members. In this regard, the TDS subgroup has received its share of action items. A significant number of these relate to the interface between the German Space Operations Center (GSOC) at Oberpfaffenhofen and the SFOF at Pasadena since, during Mission Phase II, Project control will be in West Germany, while a majority of the tracking and data system support for *Helios* will be provided by the DSN with network control in Pasadena. During this Phase II time period, the DSN will be accumulating and forwarding in real-time, spacecraft telemetry data to Germany, and in return will be receiving from GSOC command instructions to be sent to the spacecraft. In addition, the German Effelsberg and Weilheim antenna facilities will be used to provide a portion of the tracking and data acquisition support. These factors present many interfaces which must be resolved—hence are the subject of a number of action item assignments, since the overall interface is too complicated to be treated as a single topic. The generation of responses to action items is, therefore, a continuing process requiring significant activity during the intervals between Joint Working Group Meetings.

V. Preparations for the Sixth *Helios* Joint Working Group Meeting

The Jet Propulsion Laboratory is honored to have been selected to be the host for the Sixth *Helios* Joint Working Group Meeting. These meetings, which are held semi-annually, are alternately held in the United States and in the Federal Republic of West Germany. The meetings, which last approximately one week, encompass all aspects

of the *Helios* Project activities. Representatives of each experiment; the spacecraft structure, thermal, power, etc., subsystems; the launch vehicle; launch support facilities; the supporting tracking and data systems; and the Mission Operations organization participate in these meetings (Ref. 4). In all, approximately 150 to 200 people are in attendance. The Working Group Meetings open and close with General Sessions embodying all participants, the intervening period being occupied with individual and joint meetings between the aforementioned subgroup membership representing the experimenters, launch vehicle, etc. Hosting such a meeting obviously requires considerable prior preparation. Not only must adequate conference room areas be obtained, but the host committee must concern itself with such mundane matters as hotel reservations for the visitors, reserved parking areas, secretarial services, and general information pamphlets. Since the Sixth *Helios* Joint Working Group Meeting is scheduled for April 26, to May 3, 1972, JPL host committee activities have already started in preparation for this meeting. Also, technical agenda items are being formulated even though the final agendas cannot be prepared until just prior to the meeting since action item activity, etc., are continuing subjects. Nonetheless, during this reporting period, JPL preparation activity in anticipation of the forthcoming Sixth *Helios* Joint Working Group Meeting has been initiated.

VI. Conclusion

This article has only attempted to highlight some of the more significant JPL/TDS activities in support of Project *Helios* since the Fifth *Helios* Joint Working Group Meeting held in Oberpfaffenhofen, West Germany, October 20 to 27, 1971. Obviously, a considerable amount of technical detail activity also transpired during this time period, but it is beyond the scope of this article. Such information is better retained in the Project working files, at least until it appears in official interface documents. Nonetheless, from an overall Project viewpoint, the TDS has made continued and steady progress since the last Joint Working Group Meeting. The results of this progress are being reflected in the various *Helios* Spacecraft/TDS Interface Documents that are scheduled for publication in the weeks and months ahead. These and other significant factors will be treated in future articles of this series.

References

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